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SPACE STATION MANAGEMENT PLAN

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SPACE STATION MANAGEMENT PLAN

I. INTRODUCTION

The purpose of the National Aeronautics and Space Administration (NASA) Space Station Management Plan is to define management responsibilities, resources, controls, and processes necessary to establish accountability for the development of the Space Station through all levels of program management. This plan is in conformance with the management requirements established in the Program Approval Document (PAD), the Program Requirements Document (PRD), and the Program Definition and Requirements Document (PDRD), which are controlled by the Administrator, the Associate Administrator, and the Program Director, respectively.

The Space Station Management Plan is based on management concepts proven successful with previous manned space programs. The approach draws on NASA and contractor experience gained from these programs. At the same time, NASA recognizes the increased challenge posed by the technical and organizational complexity of the Space Station.

The assignment of Space Station responsibility within NASA is multi-level and similar to that employed in other manned programs, such as Apollo. These levels are identified as Level O, the Agency Administrator; Level I, the Associate Administrator for Space Station; Level II, Space Station Program Office; Level III, Space Station project offices at each NASA center; and Level IV, the work package contractors. SSP management is focused in the Level II Space Station Program Office (SSPO). The lead technical responsibility for Space Station Project Management and the contractors is distributed among the Level III NASA centers based on their unique skills, scientific and technical disciplines, and demonstrated experience. In turn, parallel work package contractors at Level IV have responsibility for SSP design and development. Primary Program management responsibilities and relationships are shown in Figure 1.

The SSP with the centers and their contractors will produce the Space Station by phases. The phases include feasibility establishment; concept definition and key performance requirements development; and then design, development, test, and Space Station deployment phase for which this Plan applies.

A recompetition is held and new contracts awarded at the end of each phase to maximize Program content and optimize cost. However, at no time is the entire Program entrusted to a single contractor. Rather, the parallel prime contractors are each responsible for their respective work package

development, and multiple support contractors are used to assist NASA in their management and integration. The management approach shown in Figure 2 summarizes the interactions within the SSP to implement Program, resource, technical, and integration control. Through this approach, the entire Program remains integrated and proceeds with order and discipline to achieve its objective.

The structure of the Space Station Management Plan is shown in Figure 3. The Plan is separated into four major areas: Introduction, Organizations, Controls, and Processes. The Introduction describes the management plan structure. Section II identifies and describes the basic organizations --NASA, other government, industrial, and international-- involved, and their respective responsibilities and resources. In addition, other resources not directly linked to these basic organizations, such as the Technical and Management Information System (TMIS), Space Station Information System (SSIS), and the Software Support Environment (SSE) are included in this section. The controls imposed on Program management and integration are described in Sections III and IV. These sections include the management controls which provide the Program performance incentives and ensure oversight review by non-advocates and senior NASA management. The two sections also include Program controls which direct the SSP technical content and provide for performance, budget, and schedule accountability. The remaining sections, V through XI, describe the management and integration processes that link the wide-ranging SSP activities and participants at each Program level.

II. ORGANIZATION, RESOURCES, AND RESPONSIBILITIES

The organizations responsible for the SSP are shown in Figure 4. Level 0 is the Office of the Administrator at the NASA Headquarters in Washington, D.C. This office sets policy for the Agency, develops joint policy with other U.S. and foreign government agencies, and coordinates the NASA Headquarters' offices and centers.

The Level I Office of Space Station (OSS), headed by the Associate Administrator for Space Station, is also located at NASA Headquarters. OSS has responsibility for Space Station policy, goals and objectives, top level requirements, and external interfaces and agreements.

The NASA Headquarters SSPO, headed by the Program Director, is located in Reston, Virginia. The major functional responsibilities of the SSPO are Program management; requirements definition and control, and system development; configuration control; end-to-end Program integration, test, and verification; development oversight and assessment; and technical and administrative support.

Level III consists of work package and international partner organizations located at the Marshall Space Flight Center (MSFC), Alabama; Johnson Space Center, Texas; Goddard Space Flight Center (GSFC), Maryland; Lewis Research Center (LeRC), Ohio; the Kennedy Space Center (KSC) in Florida; and the Canadian, European Space Agency (ESA), and Japanese partners. The primary work packages are responsible for designing, developing, testing, and evaluating the Space Station elements and distributed systems as summarized in Figure 5, and for work package management. KSC is responsible for common ground support equipment, SSP pre-launch processing, flight, and post-launch processing with the National Space Transportation System (NSTS). In response to Intergovernmental Agreements (IGAs) between participating countries and the U.S. government, and Memoranda of Understanding (MOUs) between NASA and the respective space agencies, the international partners are responsible for the following:

- Canada for the Mobile Servicing Center (MSC),
- The ESA for the Columbus pressurized laboratory module, a polar platform, and a man-tended free flying platform,
- Japan for a pressurized laboratory module and exposed facility, and an experiment logistics module.

Level IV prime work package development contractors located at each of the four work package centers are responsible for the detailed designs of the Space Station's elements and distributed systems; their manufacture, integration and test; and associated engineering and technical services.

The hierarchy of primary documents that control the Program is shown in Figure 6. The Program Approval Document (PAD) is the contract between the NASA Administrator and Level I which established the SSP. The response of Level I to the PAD is the PRD, which reflects Level I requirements and policy, controlled milestones, budget allocations, and external agreements. The Program Plan establishes the contract between Levels I and II, and provides guidance and direction to Level II Offices. Level II's response to the Program Plan and the PRD is the PDRD and its subsidiary documents which contain Level II's performance and functional requirements, and its controlled milestones, budget allocations, and external agreements. Level III's response is a family of project plans which are the contract between Level II and III, and Level III requirements documents which drive prime contractors and supporting development activities. Level IV's response is in the form of prime contracts and specifications.

Responsibility for ancillary aspects of the Program are distributed throughout various NASA Offices, which include

the Office of Commercial Programs, the Office of Space Science and Applications, the Office of Space Flight, the Office of Safety, Reliability, Maintainability, and Quality Assurance, the Office of Aeronautics and Space Technology, and the Office of Space Operations. The roles of each of these participants are identified in the definition of the processes in which they participate.

III. MANAGEMENT CONTROL

Management control processes are in place to report status, elevate issues and facilitate their resolution, coordinate planning efforts, provide guidance, evaluate performance, and motivate and reward excellence. The three major management control processes are:

- Management oversight - a hierarchical review process intended to report on status, issues, and plans;
- External oversight - a means of obtaining an external scrutiny of the program's activities;
- Performance evaluation - the processes provided to encourage and reward personal and organizational excellence.

The SSP has an extensive management oversight process. The process consists of reports and reviews intended to provide all levels of management a consistent assessment of the status of the Program and future projections. Management reviews are accomplished at all levels and vary in nature and frequency.

NASA and contractor weekly status reports are generally informal and brief. Monthly reports are more formal and more detailed. They start at the lowest level within each contractor organization and proceed vertically through a contractor and government management chain, culminating in monthly General Management Status Review (GMSR) with the Administrator. Quarterly reviews are used to provide detailed horizontal interchange of management issues and status. The major milestone reviews are used to gain a detailed understanding of the Program's progress.

External oversight is provided primarily by two senior bodies. Committees have been formed by the NASA Advisory Council and the National Research Council to oversee the SSP. In support of these committees, subcommittees examine disciplines of special interest. These reviews provide feedback to the NASA Administrator and to the Associate Administrator for Space Station on the conduct of Program activities as viewed by experienced and objective experts.

NASA has strengthened the role of the Associate Administrator for Space Station and the Program Director by making them key members of the personnel and organizational performance evaluation. The Associate Administrator not only has the authority to evaluate the performance of his supporting center Directors on certain key objectives, but is also the fee determination official on all the work package contracts. The Program Director has a similar authority in the performance evaluation of his supporting project managers at the NASA centers, and plays a critical role in developing work package contractor fee recommendations. The various review mechanisms imbedded in the Program and externally provide the needed insight for the Associate Administrator and Program Director to make effective use of their performance evaluation authority.

IV. PROGRAM CONTROL

Program control processes are dictated by the unique, dynamic Space Station development environment and external influences. The technical and organizational complexity of the SSP presents a challenge to NASA management to maintain insight into cost, schedule, and performance. Critical factors that affect the design of these processes are the long operational life of the Space Station, life cycle costs, and evolution planning.

Formal procedures have been established at all Program levels from the Administrator down to the work package contractors to control technical changes, schedules, and the budget process. The SSP has defined a budget baseline and established controls to meet the cost, schedule, and technical commitments of the Program. The budget formulation process begins each year with the issuance of guidelines to the centers which reflect any changes resulting from actions taken by the Congress, the Administration, and NASA management. The work package project managers are responsible for ensuring that the guidelines provide for sufficient resources to accomplish the planned work. New requirements or changes are identified and justified through the change control procedures. The project offices hold reviews with the contractors and center management, and subsequently with the SSPO, Level II. Level II is responsible for integrating the budget requirements of all the work packages and validating the consistency of the budget, schedule, and performance requirements. This budget review process continues to the next higher level and is ultimately reviewed with the NASA Adminstrator in the spring. All actions and decisions made in the spring budget process are reflected in a subsequent guideline which reinitiates the budget process. The process culminates with the annual NASA budget submission to the

Office of Management and Budget (OMB) and the development of the President's budget.

An operating plan is established at the start of each fiscal year and updated at mid-year to reflect current planning. Each major contractor develops a Performance Measurement System (PMS). The PMS status of planned versus actual accomplishments and expenditures is presented to NASA management monthly and provides the contractor's best assessment of his effort. This project-level data is integrated and reviewed monthly by the SSPO, and continues through to the GMSR where the Administrator and Associate Administrator are informed of current activities. Actions can then be taken as necessary to ensure the success of the overall Program.

As a long term cost control mechanism, the Program institutes a Design-to-Life-Cycle Cost (DTLCC) control process. The objective of implementing a DTLCC process is to identify and establish detailed designs that maximize responsiveness to user requirements while meeting life cycle cost objectives within total and annual development (DDT&E) budgets.

The most significant milestone events that have been externally established are reflected in the PAD, which is controlled by the NASA Administrator. The SSP has an established integrated network of subordinate schedules that provide program management with adequate control mechanisms and visibility to ensure that commitments are met. The critical events requiring interface between one organizational element and another have been identified and the responsibility to accomplish each event has been clearly designated. Inter-organizational hardware and software, referred to as "intersite deliverables," are monitored by the SSPO, Level II. Level II fora provide mechanisms for the integration of Program schedules, identification of issues, review and analysis of schedule changes, and resolution of schedule conflicts.

A major key to Program performance, cost, and schedule success is the establishment of adequate reserves. The SSP reserves provide required flexibility to solve problems that are uncovered by the internal NASA management process. The Program Director has total responsibility for the management of these resources.

The SSP configuration management process has been firmly established, and the responsibilities for configuration identification, configuration control, configuration accounting, and configuration verification of baselined SSP documentation hardware and software have been assigned (see Figure 6). The configuration management process includes the integration of Program requirements, traceability of

requirements, control of changes to requirements, and the accomplishment of management and technical requirements reviews. This configuration management process also is used to baseline and control changes to all Program hardware and software. A major part of this process is the progressive placement of the Program under configuration control as a result of the major milestone reviews shown in Figure 7.

A structure of configuration control boards is in place to baseline management and technical requirements, disposition changes to those requirements, and ensure proper implementation of approved changes. This structure is shown in Figure 8. Methods to operate these boards and process changes are established. Processing of changes to Program requirements is accomplished in a formal manner which ensures Program-wide integration of each change and identification of all impacts prior to change disposition.

To facilitate the responsive exchange of management and technical information and assist the implementation of Program controls, the TMIS has been established under the direct control of the SSPO. With the TMIS, the SSP participants are linked to an interactive system which allows the ready reporting of schedule, cost, and performance data. The automated configuration management system also operates under TMIS.

V. SAFETY AND PRODUCT ASSURANCE

The purpose of the Safety and Product Assurance (S&PA) process is to ensure that Space Station systems and elements are developed and operated which are safe and highly reliable over its operational life. Ensuring the well-being of the Space Station, ground personnel, and flight crew permeates every aspect of SSP. The S&PA process detects and prevents requirement non-compliance and identifies areas of potential risks and their probable consequence. Although risks cannot be entirely eliminated from spaceflight, they can be understood and minimized. The S&PA process consists of four major elements: safety, reliability, maintainability, and quality assurance for hardware and software.

The driving SSP safety, reliability, maintainability, and quality assurance requirements for this process are established in the baseline controlled PRD and PDRD. In addition, the S&PA process is based on policies and requirements contained in NASA standards and procedures which have been successful with other manned programs. The implementation of the S&PA process is through specific plans which are prepared by the SSPO, the Level III project offices, and the work package contractors. The

international partners also define safety and product assurance requirements, and develop respective implementation plans. Level II is responsible for reviewing the international process requirements and ensuring that these are equivalent to or exceed NASA's. NASA has final authority for the resolution of safety issues. This ensures that SSP configuration changes are not detrimental to established safety and product assurance policy and requirements.

The S&PA process is implemented through the management approach shown in Figure 2. The S&PA function for the SSP is provided for by the Office of Safety, Reliability, Maintainability, and Quality Assurance, allowing a direct path of communication to the NASA Administrator. This provides an independent assessment of the overall implementation and compliance to the Agency safety, reliability, maintainability, and quality assurance requirements and policies. With this management approach, there is increased interaction of the S&PA process with the technical integration activities and operations. The result is continuous visibility, understanding, and integration of safety and product assurance requirements and policy throughout the Program. In addition, the S&PA process provides for a high degree of involvement in risk management and assessment of SSP alternatives.

VI. TECHNICAL INTEGRATION

The purpose of technical integration is to ensure "first-time" manned mission readiness and performance integrity of the on-orbit Space Station with minimal risk. Technical integration encompasses all vertical and horizontal organizational aspects of the SSP to ensure:

- design compliance with performance requirements,
- development of baseline configuration documentation,
- verification for mission readiness,
- efficient and timely integration to achieve Level I Program milestones.

SSP technical integration interrelates system engineering, system integration, system verification, the SSIS, operations and utilization, externally provided transportation systems, and the international program.

SSP technical integration is implemented through the management approach shown in Figure 2 and the synergistic interaction of organizational structures to achieve Program-wide horizontal and vertical integration. The System Engineering Review (SER) process functions to coordinate and resolve Program-wide design, technical,

integration, and verification issues, and to develop recommendations for implementation through the line organizations and the configuration control board structure.

The general technical integration activities include:

- establishing performance requirements, interface definition, and baseline Program configuration,
- allocating and managing resources, margins, and reserves,
- developing plans and processes to implement baseline requirements,
- developing and maintaining a risk management process to assess alternatives and work-arounds,
- establishing requirements and developing a process to certify safe, manned mission readiness,
- establishing and implementing a process to integrate and coordinate all technical activities to achieve the baseline on-orbit Space Station configuration,
- monitoring and assessing Level III and Space Station Program Participant (SSPP) designs and compliance.

It is the responsibility of Level II to establish Program-wide performance, interface, schedule, and cost requirements. Level III and the SSPP have the responsibility for developing and providing the systems, elements, and equipments including payloads, for integration and verification in conformance with these Level II requirements. Figure 9 summarizes the Level I, II, and III technical integration responsibilities, processes, and products. Coordination and interaction with other SSPP and organizations are accomplished through the SER process. Technical integration is facilitated by the utilization of key management tools such as the Engineering Master Schedule (EMS), the Engineering Data Base (EDB), through TMIS, and the Schedule and Action Coordination System (SACS).

System integration is the process for defining, coordinating, overseeing, assessing, and reporting technical integration activities to achieve incremental assembly and final on-orbit Space Station manned, mission readiness within performance, milestone, and budget requirements. NASA Level II is responsible for the total SSP integration. This responsibility includes integrating systems, elements, international elements, software, NSTS and other external elements, user and customer payloads, platforms, operations, facilities, support equipment, and information systems, which provide the means for Space Station command, control, and communications.

The key Space Station system integration responsibilities include:

- developing a process for technical integration, coordination, and oversight among SSP vertical and horizontal organizations;
- establishing a single Level II NASA system integration office to implement responsibilities;
- maintaining and assessing the status and schedule of technical integration activities;
- providing status reports, integration alternatives, and assessments of integration activities;
- assessing Program-wide commonality;
- performing independent assessment of performance, requirements, schedules, cost, safety and quality assurance;
- developing tools to ensure accountability and oversight for activities from ORU-level through on-orbit assembly to final Space Station configuration and operations;
- identifying, coordinating, and overseeing intersite deliverables;
- defining, managing, and controlling the interfaces between SSP elements, systems, the SSIS and the external elements such as the NSTS and the Tracking and Data Relay Satellite System;
- developing and managing a Program-wide installation, assembly, and checkout concept
- developing a pre-launch and post-launch integration concept;
- developing contingency integration alternatives

Specific system integration responsibilities, processes, and products are shown in Figure 9.

Verification is the process of certifying that the Space Station satisfies all design and performance requirements, is mission ready, and is safe for manned activity. System verification is established through comprehensive Program-wide master verification requirements and plans. The overall Space Station system verification process is based on the following principles.

- All SSP flight elements, systems, software, and platforms, including international elements, users and customers, support equipment, and facilities are verified.
- Verification is performed by inspection, demonstration, analysis, or test, or a combination of these methods.
- Verification is conducted prior to launch. Where subsequent on-orbit verification is required, it is limited to subsystems or systems that are

not mission or safety critical.
- Successively higher levels of verification are additive, not repetitive.
- Confirmation of the Space Station integrity and the final verification is performed during on-orbit assembly and between assembly flights.
- The Space Station is verified as being safe for prior to the initialization of manned activity
- System verification is managed and controlled through a single NASA Level II office.
- Multi-system software and flight software is independently validated and verified.
- Verification includes an end-to-end SSP system test to confirm Space Station performance with SSIS element, users, facilities and ground elements.

Specific system verification responsibilities, processes, and products are identified in Figure 9.

The SER process shown in Figure 10 is the primary process for coordinating technical integration activities. The SER functions to coordinate and resolve Program-wide technical integration and verification issues and to develop recommended solutions. A key SER function is the coordination and integration of activities between Level II, Level III, the work package contractors, users, the transportation systems, and the international partners to achieve Program milestones. The SER includes representatives from Level II and Level III as well as the international partners, information systems, users, and the other SSPP. A SACS process augments the SER as a management process to effect horizontal integration across the SSP and vertical integration requiring Level II and Level III interaction. The SACS manages and tracks all SSP system integration activities and intersite deliverables.

The Engineering Master Schedule (EMS) is also a key management tool and identifies the flow of required products and intersite deliverables between Level II, Level III, the international partners, and external projects. Level III, the international partners, and other SSPP are responsible for the development and synchronization of milestones with Level II Program controlled milestones.

An Engineering Data Base (EDB) is also maintained to achieve technical integration of Program-wide shared databases and allow the exchange of information. The EDB will include data for on-orbit components, ground support and flight support equipment, NASA supported training and test equipment, design tools, and dedicated SSP facilities and sites.

The SSE provides a common set of rules, tools, and procedures for the development of Space Station software. The SSE Framework automates the process control of the software life-cycle, and is the controlling entity that directs the activity of SSE users. It records and tracks the status of programs, tests, documents, and key events in the software life-cycle. This data provides NASA software managers with automated configuration management, automated control of the software integration process, and automated on-line project status and schedule reporting. Furthermore, the Framework coordinates and controls the activities of software developers and testers, and ensures that all software is integrated in the correct sequence and has passed all quality checks.

Elements of the SSIS are supplied by the NASA Office of Space Station, the Office of Space Operations, and the Office of Space Science and Application. A joint technical integration plan is contained in a joint MOU. Detailed technical integration is performed by a series of discipline-oriented working groups which are responsible for development of specifications and standards. These specifications and standards are imposed on all SSIS elements by each of the NASA Offices via their respective configuration management processes.

VII. INTERNATIONAL INTEGRATION

NASA and each international partner are each responsible for the management of their respective Space Station activities consistent with the provisions of the MOUs. The MOUs, approved at Level 0, establish the management mechanisms to: coordinate the respective Space Station design, development, integration and verification activities of NASA and each partner; establish applicable requirements; ensure safe operations; establish the interfaces between the Space Station elements; review decisions; establish schedules; review the status of activities; report progress; and resolve issues and technical problems.

Programmatic and technical linkages between the SSP and each partner are established through the following joint agreements: 1) Joint Program Plan (JPP), 2) Joint Program Requirements Document (JPRD), 3) Joint Program Definition and Requirements Document (JPDRD), and 4) the joint interface documentation.

JPP's developed by each international partner for design and development details partner program content, implementation approach, and schedules relative to the NASA Level I Program Plan. The JPRDs developed by each international partner include top level requirements and their respective applicability. The JPPs and JPRDs are signed

by the NASA Associate Administrator for Space Station and the partner appointed representative. Any modification or addition to a JPP or JPRD is approved by the Program Coordination Committee (PCC).

The JPDRD contains SSP performance requirement and identifies the applicability to the partner's program. Joint interface documentation identifies the SSP interfaces and requirements in the Architectural Control Documents, the Baseline Configuration Document, and Interface Control Documents, which are applicable to partner-provided elements. Any modification or addition to the JPDRD or joint interface documents will be agreed upon mutually and signed jointly by the NASA Program Director and the partner appointed representative.

At Level I, a PCC, co-chaired by the NASA Associate Administrator for Space Station and the appointed representative from each international partner, meets periodically or at the request of either party to review design, development, and integration activities. Decisions necessary to ensure implementation of the cooperative design and development activities related to Space Station flight elements and to Space Station-unique ground elements provided by the parties are made jointly. If the Co-Chairmen agree that a specific design and development issue or decision requires consideration by another partner at the PCC level, a joint PCC may meet with either one or both of the other partners. Multilateral program reviews are held as necessary at the request of any partner. International partners are included in the management of the SSP at all levels, as shown in Figure 2.

At Level II, periodic Program management reviews enable the NASA Program Director and the program managers representing the partners to report the status of their respective design and development activities, including schedule, element performance parameters, and element interface requirements. These formal Program management reviews are held at least quarterly and chaired by NASA. Less formal status reviews are held monthly and are attended by representatives of the partners' program managers. The partners also participate in selected NASA reviews on Space Station requirements, architecture, and interfaces as defined in the JPP. Similarly, NASA participates in selected partners' reviews as defined in the JPP. Other partners also participate as appropriate.

The manned base and NASA-provided polar platform requirements, configuration, resource allocations, and element interfaces are controlled by the SSCB. As a member of the SSCB and subordinate boards as may be agreed, each partner attends and participates in considering items which affect the partner. Decisions by the SSCB may be appealed to the PCC. NASA is a member of each partners' control board,

and of such subordinate boards as may be agreed, and likewise attends and participates as appropriate.

The international partners are involved in the technical integration processes described in Section VI in a manner similar to NASA and external organizations. The International Technical Integration Panel is the technical forum for understanding and resolving issues related to international integration in support of the SSCB and PCC.

The NASA Office of Space Station and the partners are responsible for NASA/partner liaison activities. Partner representatives are assigned to NASA Headquarters, and NASA provides representatives to each partner location. In order to facilitate the working relationships between the NASA Program Director and the partner, the partner provides liaison to the NASA SSPO. Similarly, NASA provides a liaison to the partner's Level II office. In addition, by mutual agreement, the partners may provide liaison to NASA centers involved in the SSP, and NASA provides liaison to the partners' Program Offices.

VIII. TRANSPORTATION INTEGRATION

The SSP basic requirement for Shuttle launch and assembly support has resulted in the establishment of a joint SSP/NSTS integration process. The purpose of this process is to join the respective technical integration activities of each program to:

- achieve a union between the SSP and NSTS from the policy to the implementation level,
- establish a clear and appropriate distribution of responsibilities,
- establish a joint integration structure based on existing, successfully functioning organizational elements,
- provide a focal point for inter-program interaction having linkages at the appropriate organizational level to all intra-program processes,
- identify essential SSP/NSTS integration requirements.

The SSP/NSTS integration process organization structure is shown in Figure 11. This process utilizes existing Levels I, II, and III elements to the extent possible. It includes a joint management structure which unites existing program management structures at Level I and II and provides direct linkages into each program's existing configuration management, technical integration, and operations integration processes.

The principal new element within the joint SSP/NSTS integration structure is the Level II Joint Integration Panel. This panel is a balanced forum, co-chaired by the heads of the respective program integration offices, at which functional counterparts from each program's Level II office meet to review progress and resolve issues on all matters concerning Program interaction.

The SSP/NSTS integration and SSP operations integration processes are linked by including the increment management team for each assembly flight as a common element in both processes. The SSP/NSTS integration process responsibilities for each organization level and lead roles for initial integration products have been assigned as shown in Figure 12. SSP/NSTS integration documentation is jointly prepared at Level II and III as part of the technical and operations integration processes and are under configuration control by both programs.

IX. UTILIZATION AND OPERATIONS

More so than any previous NASA program, the SSP has emphasized operations and utilization planning from the beginning. Maintaining a productive, permanent manned presence in space in a safe, efficient, and cost effective manner starts in the earliest phases of the Program.

As with technical integration, utilization and operations planning and management requires a focused effort that can coordinate diverse resources to accomplish necessary goals. The environment in which these goals are accomplished involves many complex external interfaces and geographically dispersed engineering and operations capabilities. Recognition of this environment has led NASA to the present three-tiered structure for operations and utilization management. The Space Station Operations Task Force characterized these as a policy or strategic level, a program integration or tactical level, and an execution level. The SSP has implemented this structure with utilization and operations offices at Levels I, II, and III.

Strategic level (five years plus) utilization planning is performed by each partner in accordance with their MOU-based utilization shares. In the U.S., this is achieved through the Space Station Users Board (SSUB) consisting primarily of user sponsoring organizations, e.g., the NASA offices of Space Sciences and Applications, and Aeronautics and Space Technology. The partner plans are then brought together and reconciled by the international strategic level boards at Level I (Multi-lateral Control Board, User Operations Panel, Systems Operations Panel) with technical support from the Program or tactical level

operations/utilization organization (Level II). The yearly output of these boards is a Consolidated Operations and Utilization Plan (COUP) covering the next five year period. This Plan also contains top level systems operations requirements with which the utilization plans have been balanced.

The consolidated five year plan is then passed to the Level II utilization and operations organization. The integrated operations planning function is to produce from the COUP a two year Tactical Operations Plan (TOP), employing its more detailed knowledge of payload characteristics (as payload development matures) and Station/platform systems capacities, and schedules. In addition, the TOP contains logistics and Space Transportation System (STS)/Expendable Launch Vehicle (ELV) transportation plans. The SSP maintains control over and performs the functions of integrated logistics operations and manned base and platforms space (flight) operations. Communications and data handling services are also acquired and/or managed at this level. In preparing the TOP, the Level II utilization and operations organization enlists the support of the Level III to provide detailed information on Station and ground systems capabilities.

The approved TOP becomes the basis for the generation of Increment Requirements (IRs). (Increment is defined as the period of time between NSTS visits to the Space Station.) Integrated TOP preparation is a continuous process during which increment changes are negotiated and incorporated. Increment planning is also a Level II function, with involvement of Level III for technical support and implementation. Each increment is assigned an increment manager at Level II who stays with that increment process through its execution on orbit. Increment managers lead a team of Level II and Level III personnel to direct and expedite the increment planning, and payload integration services.

NASA, international partners, and user operations centers execute the increment plans as well as support the integrated tactical management functions and provide the requisite operational capability. Achievement of a permanent manned presence in space requires a substantial supporting infrastructure on the ground. The Space Station Control Center will provide the real-time systems monitoring and control capability to maintain the Space Station in a safe and usable status. The Payload Operations Integration Center will enable users to obtain the technical assistance required while preserving their autonomy to conduct user operations freely within a predetermined resource envelope. The Platform Control Center performs the combined function

for the platform. The Space Station Processing Facility and other launch site facilities will provide an efficient logistics resupply capability for both user and Space Station operations. The Space Station Training Facility will provide the means to train crews and ground control teams in order to maximize their productivity during their assigned increment. Level II facilitates the integration function of Level II and Level III activities to translate, strategic level goals and policies into Program requirements and plans which Level III implements.

In parallel with the development of a ground-based utilization and operations infrastructure, NASA incorporates utilization and operations considerations in the Space Station flight hardware and software design. Utilization and operations, system engineering and integration, and information system personnel work together through cross-membership in issue-oriented panels and working groups to arrive at optimal approaches and solutions. In all these efforts, NASA weighs the impacts on Station life-cycle cost and on requirements for NSTS services.

X. USER INTEGRATION

Potential uses of the Space Station cover a broad spectrum, which represents private industry, universities, NASA and other U.S. government agencies, and agencies of other governments. Effective and efficient utilization of the Space Station requires that potential uses be prioritized and that the user community work cooperatively with the SSP managers who supply the resources users need. Congress has mandated that user activities shall be supported as early as possible. This, too, poses a requirement on the SSP to provide a clear and well-organized process of integration of users into Space Station systems and management mechanism. SSP interaction with users is described in a four part process which captures the payload life-cycle: marketing, manifesting, integration and operations. This process is enabled by user accommodations on-board the Space Station, and by user support capabilities and services on the ground.

Potential users are given a clear picture of Space Station capabilities. The Space Station organization, as the host of all Principal Investigators (PIs), must work with the users, supplying data on resource availability, Station capabilities, and integration processes, and collecting information on user needs. This enables the Station organization and the users to jointly develop a

manifest. A Space Station Users Board (SSUB) serves to coordinate U.S. utilization plans, and these are submitted into the multilateral User Operations Panel for integration with the partners' plans for incorporation into the COUP.

Primarily a Level II function, manifesting is the process of scheduling the placement and operation of approved user payloads in the Space Station's orbital elements (manned base pressurized laboratories, attached payload accommodations, and unmanned platforms). This includes arranging for the transport of payloads and associated equipment to and from the Station via the STS or other vehicles. A Space Station Users Working Group, made up of users with approved payloads, works with the Level II and IRs. The Program assigns a Payload Accommodations Manager (PAM) for each manifested payload for the course of interaction of the payload with the Space Station, and individual payloads.

The Space Station payload engineering integration is designed with certain physical characteristics, e.g., rack size, power voltage, thermal control, fluid management, based on the best available knowledge of user requirements. The SSP assists users in payload design and integration planning. Payload integration responsibilitiees are split between Level II and Level III. PAMs work with Level III to obtain the services required by individual users. Payload safety analysis and review are the responsibility of Level II.

Once installed on the Space Station, users are provided varying degrees of assistance in operation of the payload. Preparation for and management of these activities is a Level III function. These services will be supplied by flight and ground-based systems provided by the SSP. An Investigators Working Group, made up of users whose payloads are on the Space Station, make decisions regarding payload operation, including resource conflict resolution, to be implemented using Space Station capabilities. It is the desire of many users to have a maximum degree of autonomy in the operation of their payloads. The SSP is committed to accommodating that desire within safety constraints. The SSIS links the orbital Space Station, operations activities, and distributed user facilities together in a manner that allows the user to conduct experiment operations much as he or she would in a ground laboratory environment.

During the development and assembly phases, the focus of user integration activity is on payload accommodation assessment. The payload accommodation assessment is to

define a trial payload manifest, thereby driving out the "real" requirements of Spaace Station users. This information is used to establish requirements for Space Station design, particularly in the area of laboratory module outfitting. Payload accommodation assessments influence the design of the detailed user integration process and standard user interfaces.

XI. PRIVATE SECTOR INTEGRATION

Consistent with existing and recent NASA and national policies, the SSP is committed to encouraging private sector design, financing, construction, and operation of future Space Station related systems and services, where such activities are consistent with mission requirements and overall cost effectiveness. The Program established formal policy guidelines in 1986 to encourage such participation.

Consistent with the President's recent Commercial Space Initiative (CSI), the SSP has formed an industry association to provide commercial input and solicit contractor support to address commercial participation. The SSP is examining these recommendations (in conjunction with the Office of Commercial Programs, Office of the General Counsel, and the Office of Procurement) as well as how best to review unsolicited proposals from industry for inclusion in the Program. This effort involves establishing criteria and procedures for evaluating industry recommendations and unsolicited proposals rapidly, fairly, and with minimal disruption to the ongoing SSP. It is necessary to identify as well any legislation required for NASA to implement the President's CSI effectively.

Proprietary proposals, reflected in the overall work package contract proposals, are the leading edges supporting the development of a process to integrate private sector activities into the Space Station. As such, the contractor proposals may afford the SSP an opportunity to develop operational procedures and mechanisms to integrate innovative private sector participation early on in the SSP.

The SSPO (Level II) has an important role to play in the overall process of evaluating commercial proposals for Space Station infrastructure and integrating accepted system(s) or service(s) into the Program. All Level II organizations will be involved to some degree in this technical evaluation and integration task. Level I will have the lead role on policy development as well as negotiation of agreements with prospective commercial providers.

In anticipation of significant activity in this area, Level II has begun focusing effort on a variety of issues, including development of technical evaluation criteria, establishing a technical evaluation process, definition of documentation requirements, and development of a long-term approach to commercial infrastructures management and Program integration.

APPENDIX A

ACRONYMS AND ABBREVIATIONS

ACRONYMS AND ABBREVIATIONS

AA	Associate Administrator
ACD	Architectural Control Document
BCD	Baseline Configuration Document
C&T	Communications and Tracking
CCB	Configuration Control Board
CDR	Critical Design Review
COUP	Consolidated Operations and Utilization Plan
CSI	Commercial Space Initiative
DCR	Design Certification Review
DDT&E	Design Development Test and Evaluation
DTLCC	Design-To-Life-Cycle Cost
DMS	Data Management System
ECLSS	Environmental Control and Life Support System
EDB	Engineering Data Base
EMS	Engineering Master Schedule
EPS	Electrical Power System
ESA	European Space Agency
ESC	Engineering Services Contract
EVA	Extravehicular Activity
FSE	Flight Support Equipment
FRR	Flight Readiness Review
FTS	Flight Telerobotic Servicer
GDMS	Ground Data Management System
GMSR	General Management Status Review
GN&C	Guidance, Navigation, and Control
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
I&V	Integration and Verification
IACO	Installation, Assembly, and Checkout
ICD	Interface Control Document
IGA	Intergovernmental Agreements
IR	Increment Requirements
IT&V	Integration, Test, and Verification
ITIP	International Technical Integration Panel
IWG	Investigators Working Group
JPP	Joint Program Plan
JPRD	Joint Program Requirements Document
JPDRD	Joint Program Definition and Requirements Document
JSC	Johnson Space Center
KSC	Kennedy Space Center
LeRC	Lewis Research Center
LP	Launch Package
MGR	Manager
MIP	Mission Integration Plan
MOU	Memoranda of Understanding
MSC	Mobile Servicing Center
MSIF	Multi-System Integration Facility
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
NSTS	National Space Transportation System
OMB	Office of Management and Budget
OMS	Operations Management System

OMV/OTV	Orbital Maneuvering Vehicle/Orbital Transfer Vehicle
OPS	Operations
ORR	Operations Readiness Review
ORU	Orbital Replacement Units
OSE	Orbital Support Equipment
OSS	Office of Space Station
PAD	Program Approval Document
PAM	Payload Accommodations Manager
PCC	Program Coordination Committee
PD	Program Director
PDR	Preliminary Design Review
PDRD	Program Definition and Requirements Document
PGOC	Payload Ground Operations Contract
PIs	Principal Investigators
PIO	Program Integration Office
PIP	Payload Integration Plan
PMR	Program Management Review
PMS	Performance Measurement System
POIC	Payload Operations Integration Center
PORR	Pre-flight Operations Readiness Review
PRD	Program Requirements Document
PRR	Program Requirements Review
PSC	Program Support Contractor
S&PA	Safety and Product Assurance
SACS	Schedule and Action Coordination System
SER	System Engineering Review
S&I	Systems and Integration
SRM&QA	Safety, Reliability, Maintainability and Quality Assurance
SSIS	Space Station Information System
SSCB	Space Station Control Board
SSCC	Space Station Control Center
SSE	Space Station Environment
SSP	Space Station Program
SSPF	Space Station Processing Facility
SSPP	Space Station Program Participant
SSTF	Space Station Training Facility
SSUB	Space Station Users Board
SSUWG	Space Station Users Working Group
STS	Space Transportation System
TCS	Thermal Control System
TDRSS	Tracking and Data Relay Satellite System
TIPS	Technical Integration Panels
TMIS	Technical and Management Information System
TOP	Tactical Operations Plan
UOIR	Utilization and Operations Integration Review
WP	Work Package

APPENDIX B

FIGURES

OFFICE OF SPACE STATION
MANAGEMENT RELATIONSHIPS

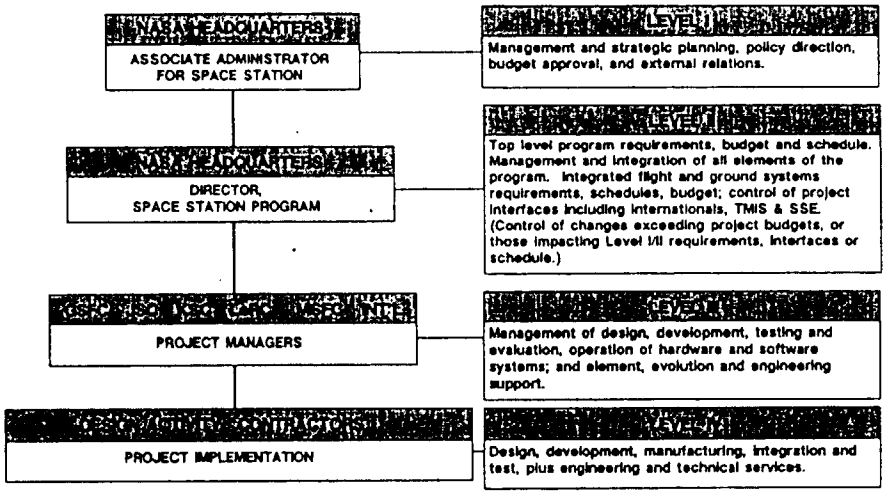
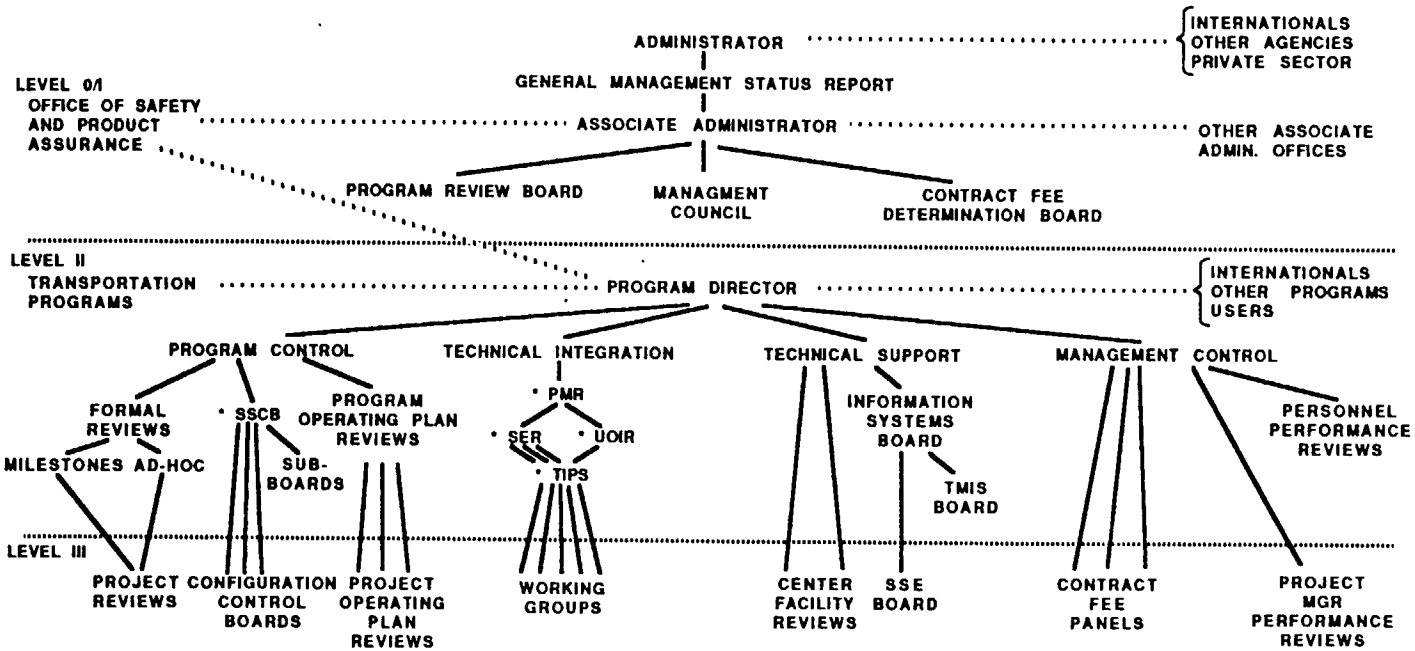


Figure 1

MANAGEMENT APPROACH



• LEGEND:
SSCB: SPACE STATION CONTROL BOARD
SER: SYSTEM ENGINEERING REVIEW
PMR: PROGRAM MANAGEMENT REVIEW
UOIR: UTILIZATION AND OPERATIONS INTEGRATION REVIEW
TIPS: TECHNICAL INTEGRATION PANELS

Figure 2

MANAGEMENT PLAN STRUCTURE

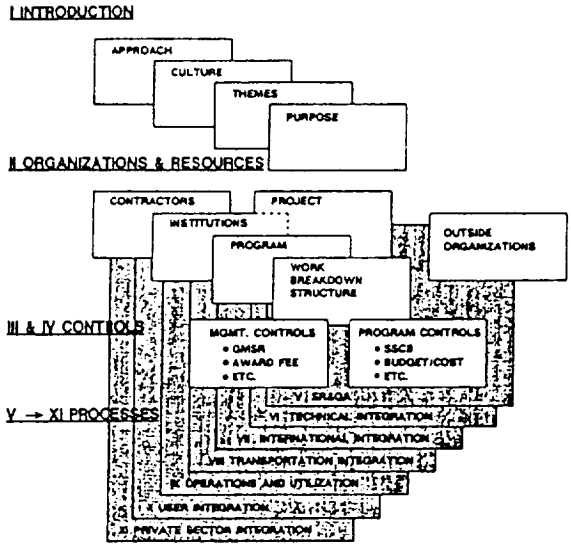
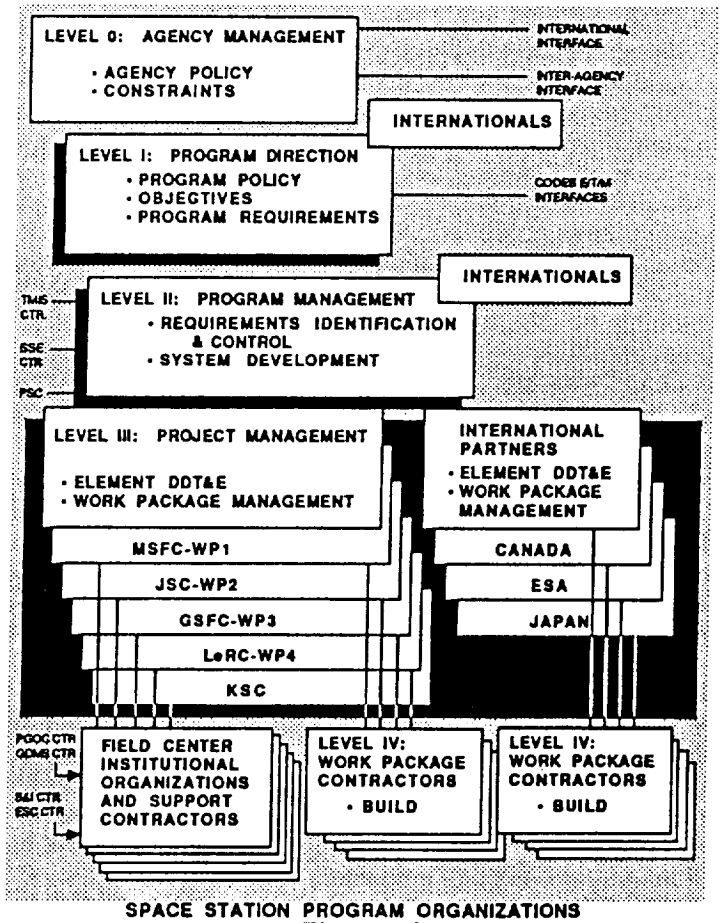


Figure 3



SPACE STATION PROGRAM ORGANIZATIONS

Figure 4

WORK PACKAGE SUMMARY DEFINITION

WP-01-MSFC

SE&I SUPPORT

- ECLSS ANALYSIS
- LOGISTICS ANALYSIS
- OMV / OTV INTERFACE ANALYSIS
- COMMON MODULE COMMONALITYANALYSIS
- PROPULSION ANALYSIS
- REBOOST ANALYSIS
- LABORATORY ANALYSIS

HARDWARE / SOFTWARE

- COMMON MODULE
  - STRUCTURE
  - DISTRIBUTION FOR:
    - DMS
    - POWER
    - ECLSS
    - THERMAL
    - COMMUNICATIONS
- ECLS SYSTEM
- PROPULSION SYSTEM
- LABORATORY MODULE OUTFITTING (1)
- LABORATORY MODULE OUTFITTING (2 OR 3)
- OMV / OTV ACCOMMODATIONS
- APPLICATIONS SOFTWARE

WP-02-JSC

SE&I SUPPORT

- GROWTH ANALYSIS
- DMS ANALYSIS
- COMM / TRACKING ANALYSIS
- LOADS ANALYSIS
- THERMAL ANALYSIS
- CONTROL ANALYSIS
- ASSEMBLY SEQUENCE DEFINITION
- STS PROXIMITY OPERATIONAL BERTHING ANALYSIS
- CREW INTERFACE ANALYSIS
- RESOURCE INTEGRATION ANALYSIS

HARDWARE / SOFTWARE

- ASSEMBLY STRUCTURE
  - TRUSS
  - MODULE INTERCONNECT
  - AIRLOCK
  - STS BERTHING
  - PWR, THERM., GIMBALS
- MANIPULATORS
- RESOURCES INTEGRATION
- THERMAL CONTROL SYSTEM
- EVA SYSTEM AND AIRLOCK OUTFITTING
- GUIDANCE, NAVIGATION AND CONTROL SYSTEM
- COMM / TRACKING SYSTEM
- DMS
- HABITAT MODULE OUTFITTING
- STS INTERFACE
- APPLICATIONS SOFTWARE

WP-03-GSFC

SE&I SUPPORT

- PLATFORM CONFIGURATION AND COMMONALITY ANALYSIS
- PLATFORMS / SATELLITES SERVICING ANALYSIS
- ATTACHED PAYLOADS ANALYSIS
- LABORATORY ANALYSIS
- STATION / PLATFORM INTERFACE ANALYSIS

HARDWARE / SOFTWARE

- PLATFORMS
- ATTACHED PAYLOAD ACCOMMODATIONS
- PLATFORM AND FREE FLYER SERVICING ACCOMMODATIONS
- LABORATORY MODULE OUTFITTING (1)
- APPLICATIONS SOFTWARE

WP-04-LeRC

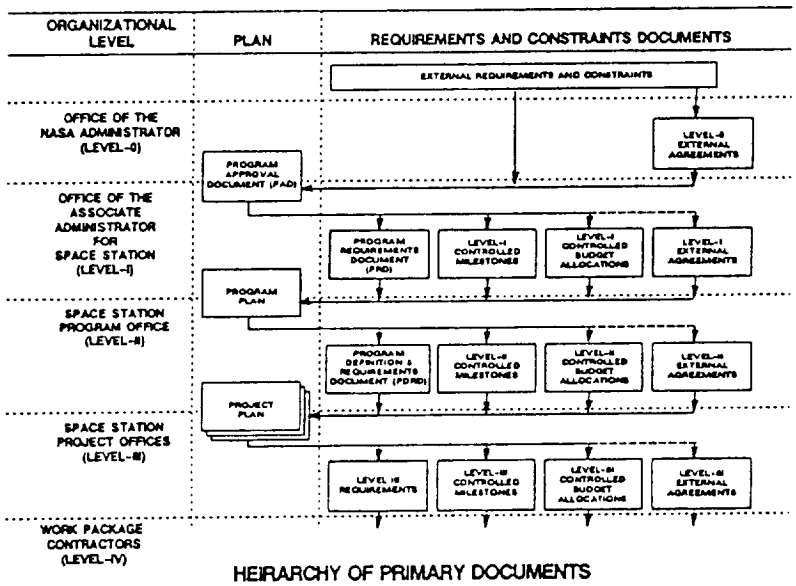
SE&I SUPPORT

- POWER SYSTEM ANALYSIS

HARDWARE / SOFTWARE

- POWER SYSTEM
  - GENERATION
  - CONDITIONING
  - STORAGE
- APPLICATIONS SOFTWARE

Figure 5



HEIRARCHY OF PRIMARY DOCUMENTS

Figure 6

PROGRAM MILESTONE REVIEWS

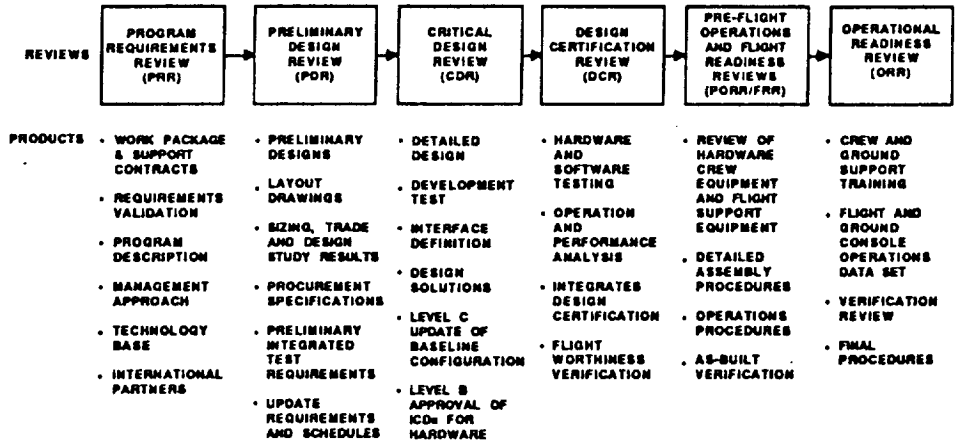


Figure 7

CONFIGURATION MANAGEMENT STRUCTURE

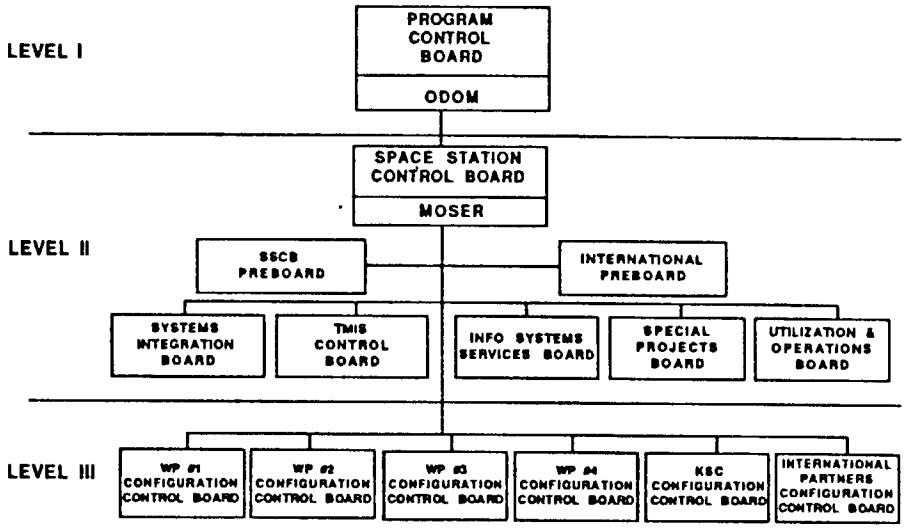


Figure 8

SSP TECHNICAL INTEGRATION

RESPONSIBILITIES	PRODUCTS	PROCESSES
LEVEL I ● POLICY & PROGRAM DIRECTION ● TOP LEVEL REQUIREMENTS ● DEFINE MAJOR SSP MILESTONES ● BUDGET	● CONTROL DOCUMENTS (PAD, PRD, PLANS) ● MOUs (NASA PROGRAMS & INTERNATIONAL) ● PROGRAM DIRECTIVES	● PROGRAM CONTROL BOARD ● INDEPENDENT SE&I ASSESSMENT ● INTERORGANIZATION COORDINATION
LEVEL II ● PROGRAM-WIDE SYS. PERF. REQUIREMENTS ● RESOURCE & FUNCTIONAL ALLOCATION ● DISTRIBUTED SYS. MGT. & FUNC. PARTITIONING ● SSP CONFIGURATION (ASSEMBLY SEQUENCE) DEFINITION & ASSESSMENT ● ENGINEERING STDS. & DESIGN CRITERIA ● SOFTWARE DEVELOPMENT REQUIREMENTS ● INTEGRATION PLANNING ● INTERFACE DEVELOPMENT & CONTROL ● ELEMENT-TO-ELEMENT INTEGRATION ● SUPPORTABILITY REQUIREMENTS ● ENGINEERING DATA BASE REQUIREMENTS ● PROGRAM-WIDE SYS. MASTER VERIFICATION CONCEPT/REQUIREMENTS (H/W, S/W) ● VERIFICATION OVERSIGHT & VALIDATION ● VERIFY SYS. INTEGRATION (INTERSITE DEL.) ● VERIFY LP & ON-ORBIT INTEGRATION ● MANAGE SUPPORT EQUIPMENT ● IV&V SYS. S/W & DEVELOP FLIGHT LOADS	● CONTROL DOCUMENTS (I&V PLANS, BCD, ACDs & ICDs) ● PDRD (SECTIONS 3 & 6) ● PROCESS REQUIREMENTS DOCUMENTS ● REPORTS/ASSESSMENTS ● ENGINEERING DATA BASE ● DIRECTIVES ● ENGINEERING MASTER SCHEDULE ● SYSTEM COMMONALITY ITEMS ● ASSEMBLY SEQUENCE ● FUNCTIONAL SCHEMATICS ● INSTALLATION ASSEMBLY & CHECKOUT (IACO) ● LAUNCH PACKAGE INTEGRATION ● ON-ORBIT CHECKOUT PLAN	● SS CONTROL BOARD/SYSTEM INTEG. BOARD ● SYSTEM ENGINEERING REVIEW ● REQUIREMENTS/DESIGN REVIEWS ● ENGINEERING MASTER SCHEDULE ● I&V PROGRAM ● SCHEDULE/ACTION COORDINATION SYS. (SACS) ● ENGINEERING DATA BASE ● DESIGN-TO-COST ● CONFIGURATION MANAGEMENT ● MULTI-SYSTEM INTEGRATION FACILITY (MSIF) ● ANALYTICAL MODELS/TOOLS ● DATA BASES ● IMPLEMENT PROCESS REVIEWS ● SAFETY/CRITICALITY ASSESSMENT
LEVEL III ● DESIGN/DEVELOP/TEST/INTEGRATE SYSTEMS/ELEMENTS ● ELEMENT SYSTEM ENGINEERING ● DEVELOP FACILITIES & SUPPORT EQUIP. ● PERFORM LP PRE-LAUNCH & POST-LAUNCH PROCESSING ● COMPLIANCE WITH LEVEL II REQUIREMENTS ● PROVIDE TECH. SUPPORT TO LEVEL II	● CONTROL DOCUMENTS (SPECS, PLANS, PROCEDURES, ICDs) ● FACILITIES & SUPPORT EQUIPMENT ● STATUS REPORTS/ASSESSMENTS TO LEVEL II ● LP INTEGRATION/NSTS INTEGRATION ● HARDWARE/SOFTWARE DOCUMENTATION - SPECIFICATION - DESIGN - PRODUCT DEVELOPMENT	● BOARDS/PANELS/WORKING GROUPS ● I&V PROGRAM ● REQUIREMENTS/DESIGN REVIEWS ● PROJECT INTEGRATION OFFICES (PIOs) ● IMPLEMENT PROCESS REQUIREMENTS ● CONFIGURATION CONTROL ● PRODUCT QUALITY ASSURANCE

Figure 9

SYSTEM ENGINEERING REVIEW STRUCTURE MASTER CHART

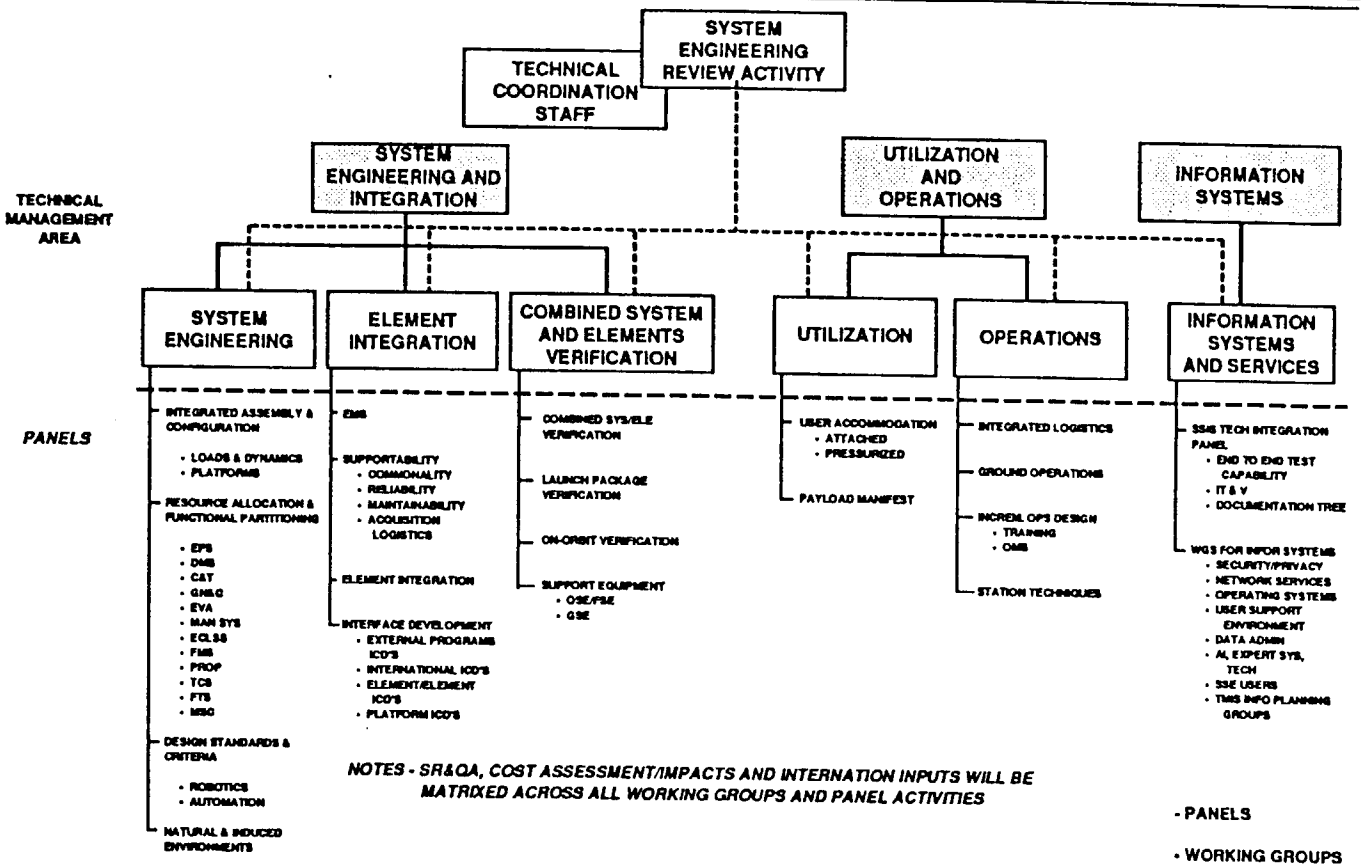


Figure 10

NSTS/SSP INTEGRATION STRUCTURE

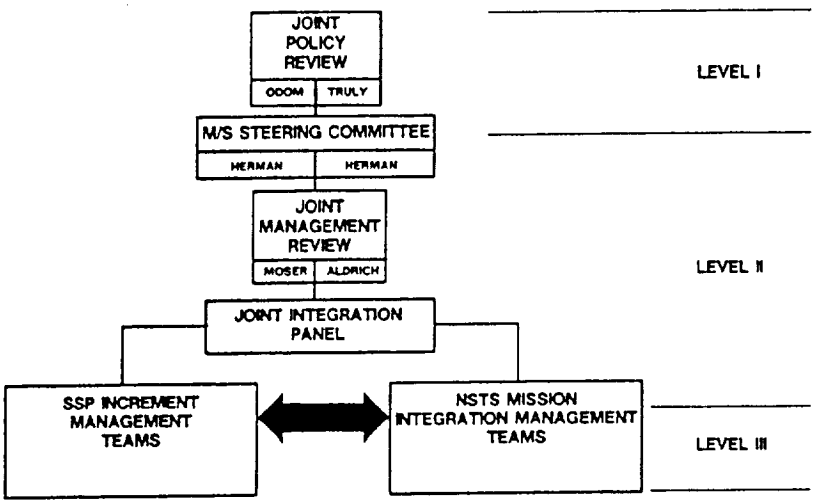


Figure 11

SSP/NSTS INTEGRATION

	RESPONSIBILITIES	PROCESSES	INTEGRATION PRODUCTS
LEVEL I	• POLICY CONTROL	• S/M STEERING COMMITTEE	• S/M MEMORANDUM OF UNDERSTANDING
LEVEL II	• BUDGET CONTROL • MANAGEMENT • PLANNING • MULTI-MISSION INT.	• JOINT INTEGRATION PANEL	• MANAGEMENT PLAN • LAUNCH & ASSY PLAN • OPERATIONS TECHNIQUES • MIP'S, PIP'S, & ICD'S • ISSUE RESOLUTION
LEVEL III & CENTERS	• SPECIFIC MISSION ACTIVITIES • LAUNCH PACKAGE MANAGEMENT • HARDWARE/SOFTWARE DEVELOPMENT • GROUND OPERATIONS	• INCREMENT MANAGEMENT TEAMS • MISSION INTEGRATION MANAGEMENT TEAMS	• MIP, PIP, & ICD SPECIFICS & ANNEXES • INTEGRATED & VERIFIED CARGO ELEMENTS

Figure 12